Estuarine Link

Sound Ecological Environment

Sound Ecological Environment

According to SAC guidance (SAC 2009a), a sound ecological environment is one that:

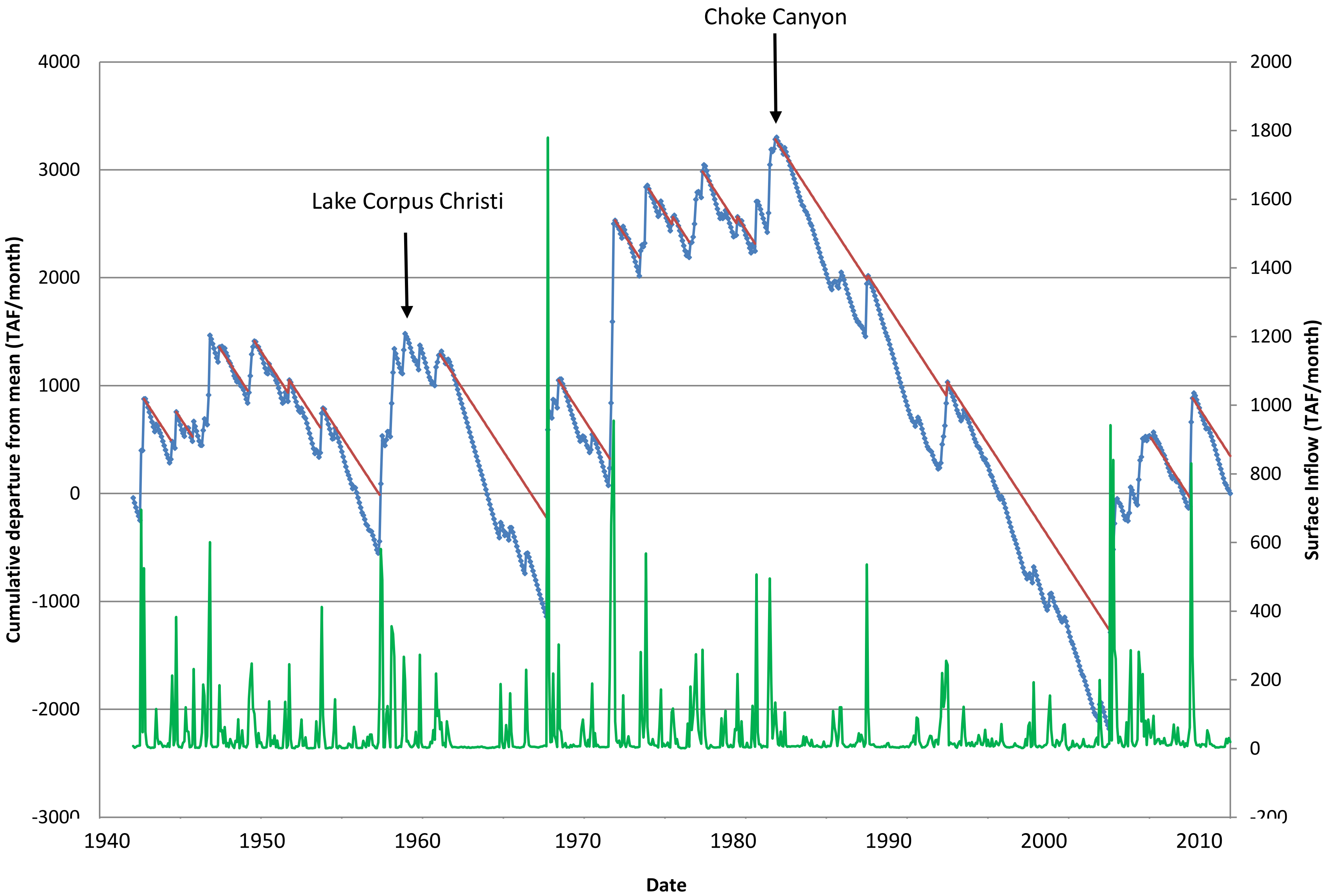
- sustains the full complement of native species in perpetuity;
- sustains key habitat features required by these species;
- retains key features of the natural flow regime required by these species to complete their life cycle; and
- sustains key ecosystem processes and services, such as elemental cycling and the productivity of important plant and animal populations.

- **1.2M cu yd from Nueces Bay ’58 alone (probably and underestimate)**

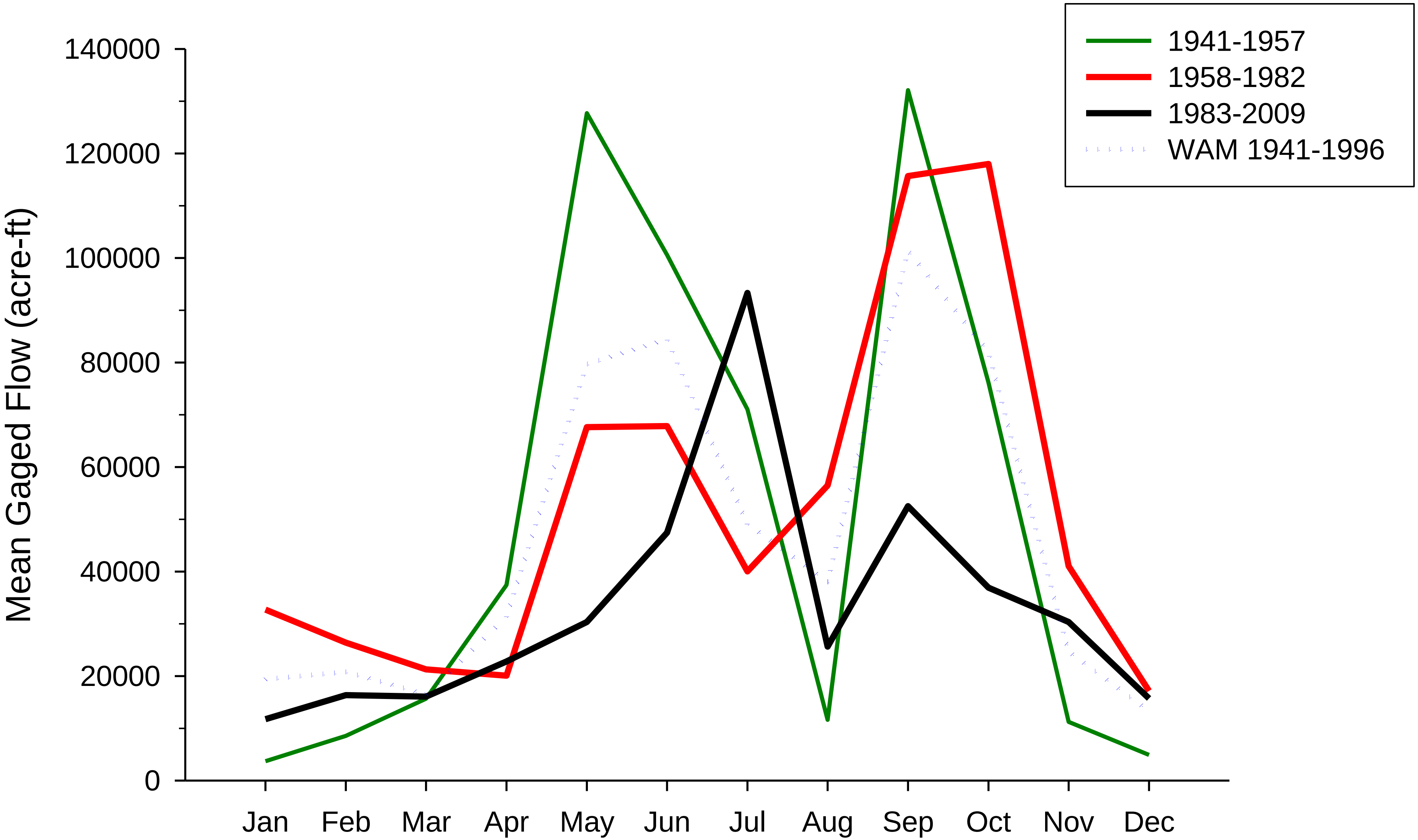
- **30’s oyster harvest ended → shell harvest → considered totally fished out (live and substrate) by 1967**

- **300’ rule but dredgers took advantage of “live” reefs during drought years of ‘50 and 60 ‘s**

Rangia cuneata



Choke Canyon
Lake Corpus Christi
4000
3000
2000
1000
0
-1000
-2000
-3000
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
1940
1950
1960
1970
1980
1990
2000
2010
Cumulative departure from mean (TAF/month)
Surface Inflow (TAF/month)
Date



Mean Gaged Flow (acre-ft)
140000
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1941-1957
1958-1982
1983-2009
WAM 1941-1996

Table 2-1: Summary of mean annual flow of the Nueces River into the Nueces Estuary (1940 to 1996)[1] and upper Nueces Delta (1940 to 1999)[2]. Time periods in both studies were based upon the construction dates of large reservoirs in the watershed.

Time Period	Mean annual river flow into Nueces Estuary (acre-ft)	Percent change from Period I	Mean annual river flow into upper Nueces Delta (acre-ft)	Percent change from Period I
1940-1957	619,000	—	127,997	—
1958-1982	614,000	-0.8%	77,989	-39.1%
1983-1996(9)	279,000	-54.9%	537	-99.6%

[1] Source: Asquith *et al.* 1997.
[2] Source: Irlbeck and Ward 2000.

Note: 1 acre-ft = 1.2336 10^3 m^3

- **1958 – Lake Corpus Christi → 1 Overbanking per year**
- **1982 – Lake Choke Canyon → 1 Overbanking every 3 years**
- **Major modifications and channelization of river preventing OB**

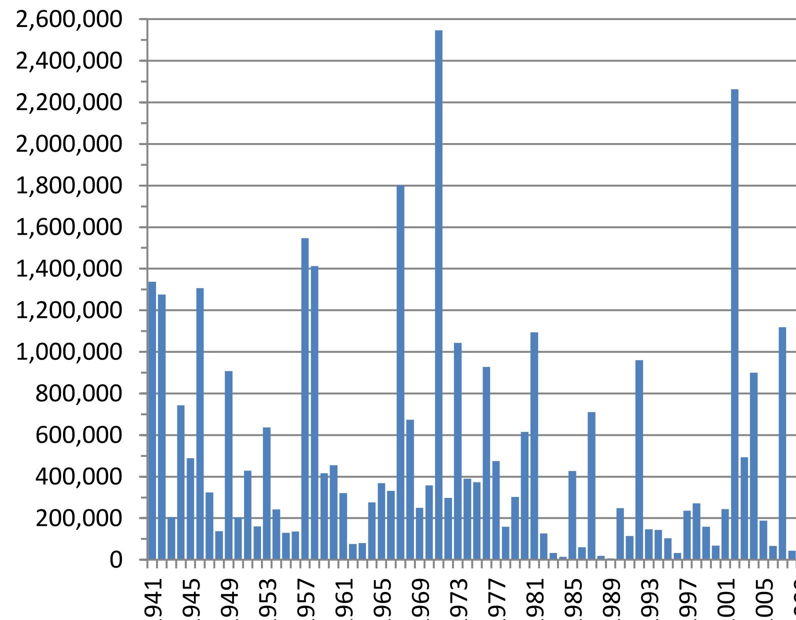
Unsound because…

- Loss/alteration of key habitat features and natural flow regimes required by indicator species

- Nutrient elemental cycling and sediment loading are compromised

- **<u>KEY POINT</u>: A modification of flow regime is required to rebuild these species and processes to sound levels**

Freshwater Inflow Analyses



Steps:

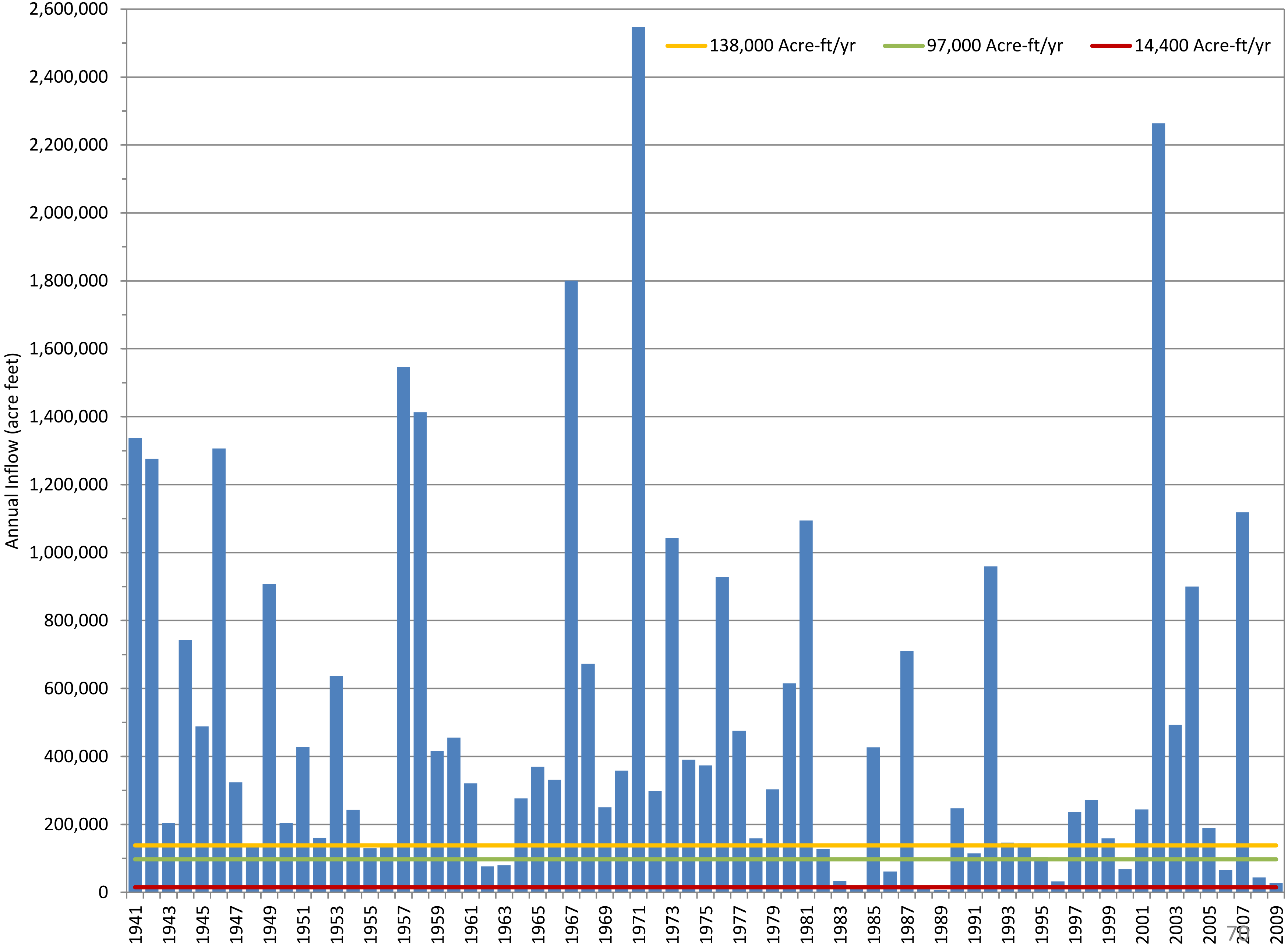
1. Characterize historical water availability patterns

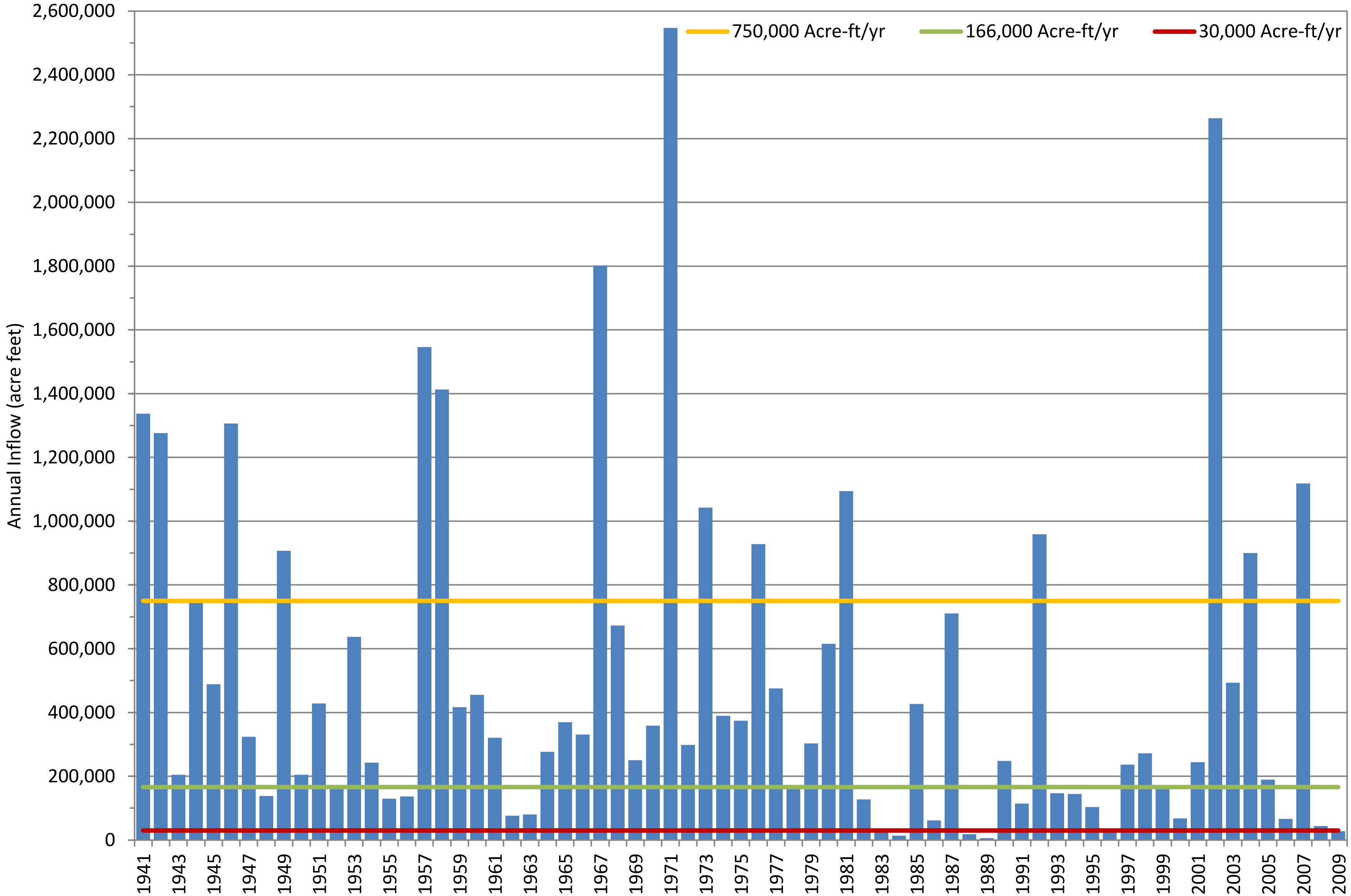
2. Examine flow and salinity relationships

3. Identify focal species (canaries)

4. Recommend flow that will create a sound environment

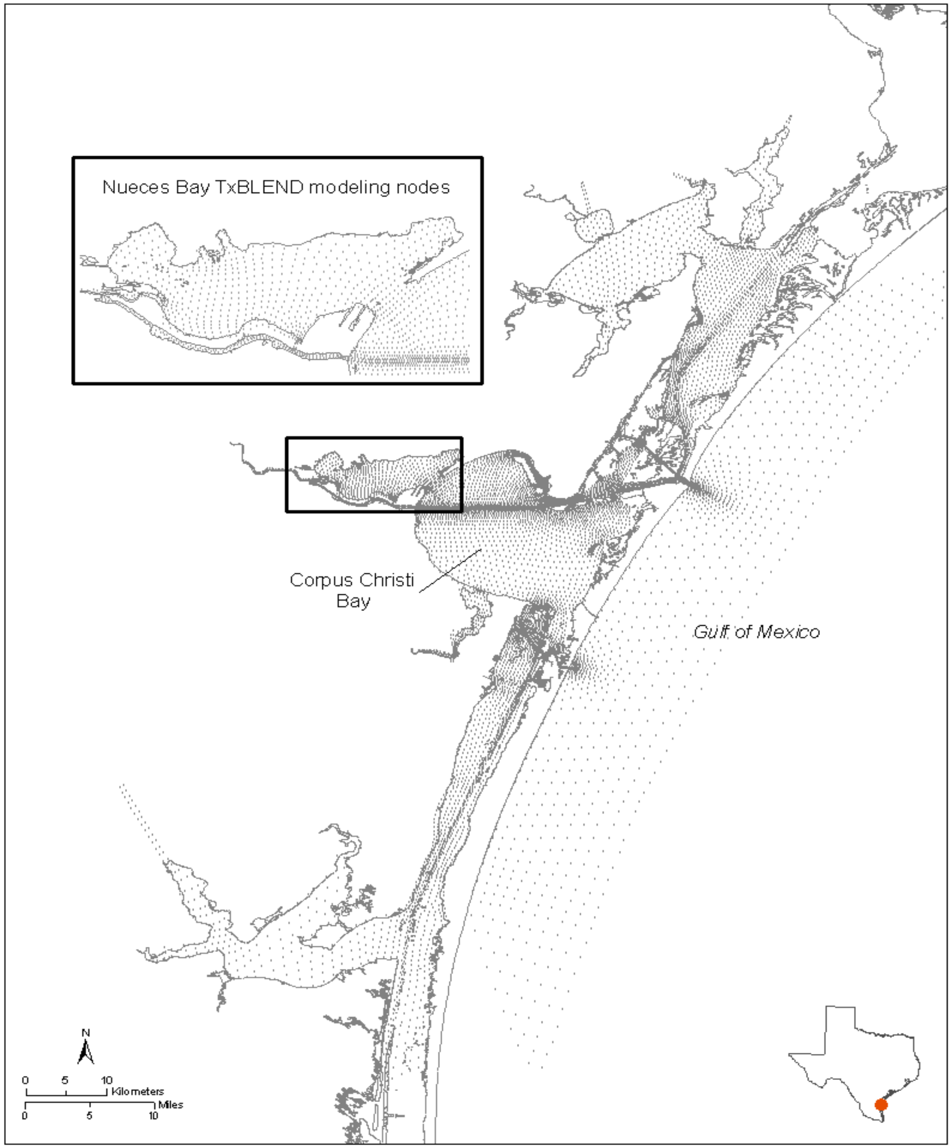
Nueces Bay inflow – Agreed Order





750,000 Acre-ft/yr
166,000 Acre-ft/yr
30,000 Acre-ft/yr
Annual Inflow (acre feet)
2,600,000
2,400,000
2,200,000
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1941 1943 1945 1947 1949 1951 1953 1955 1957 1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009

How does the bay respond to inflow?



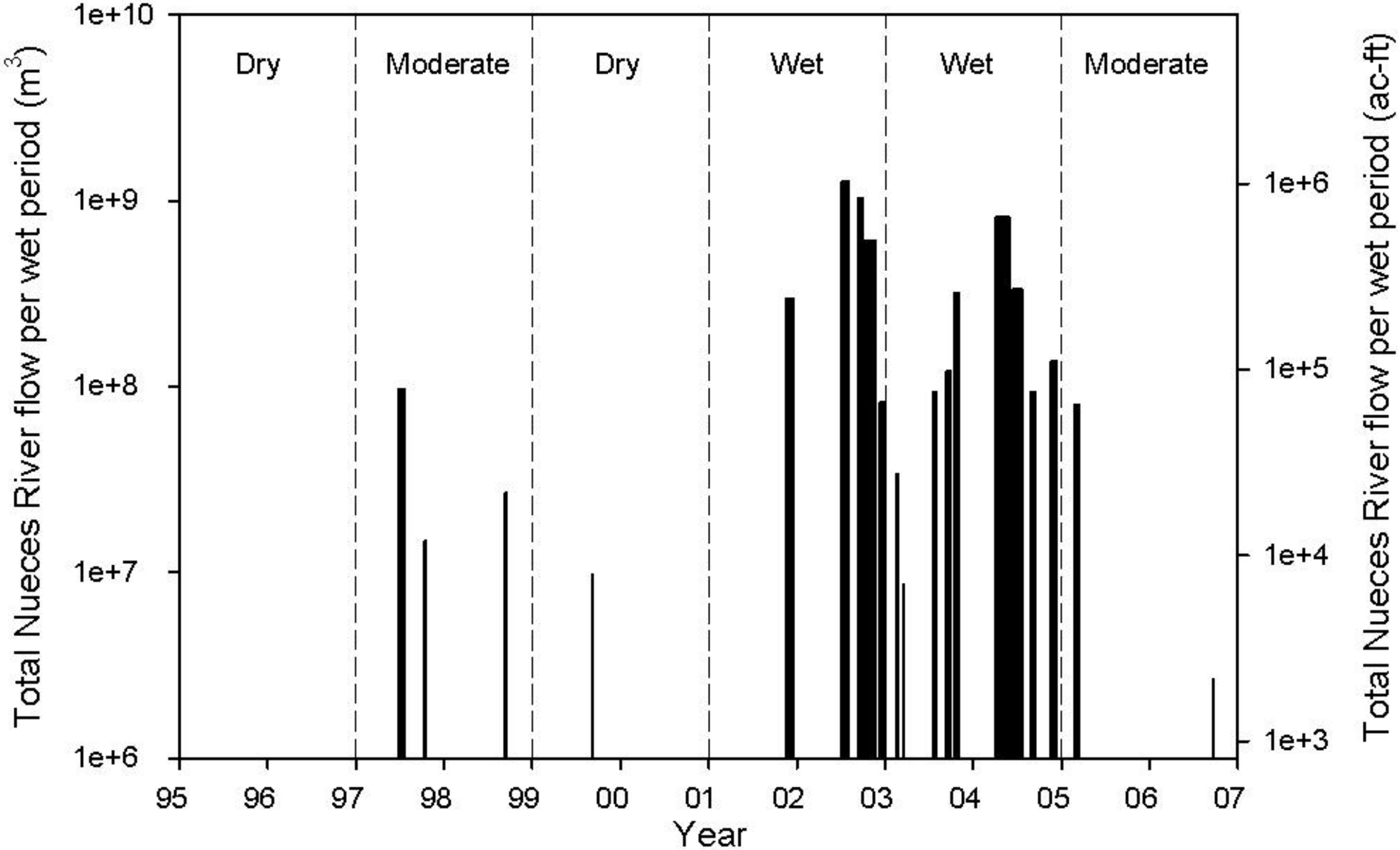
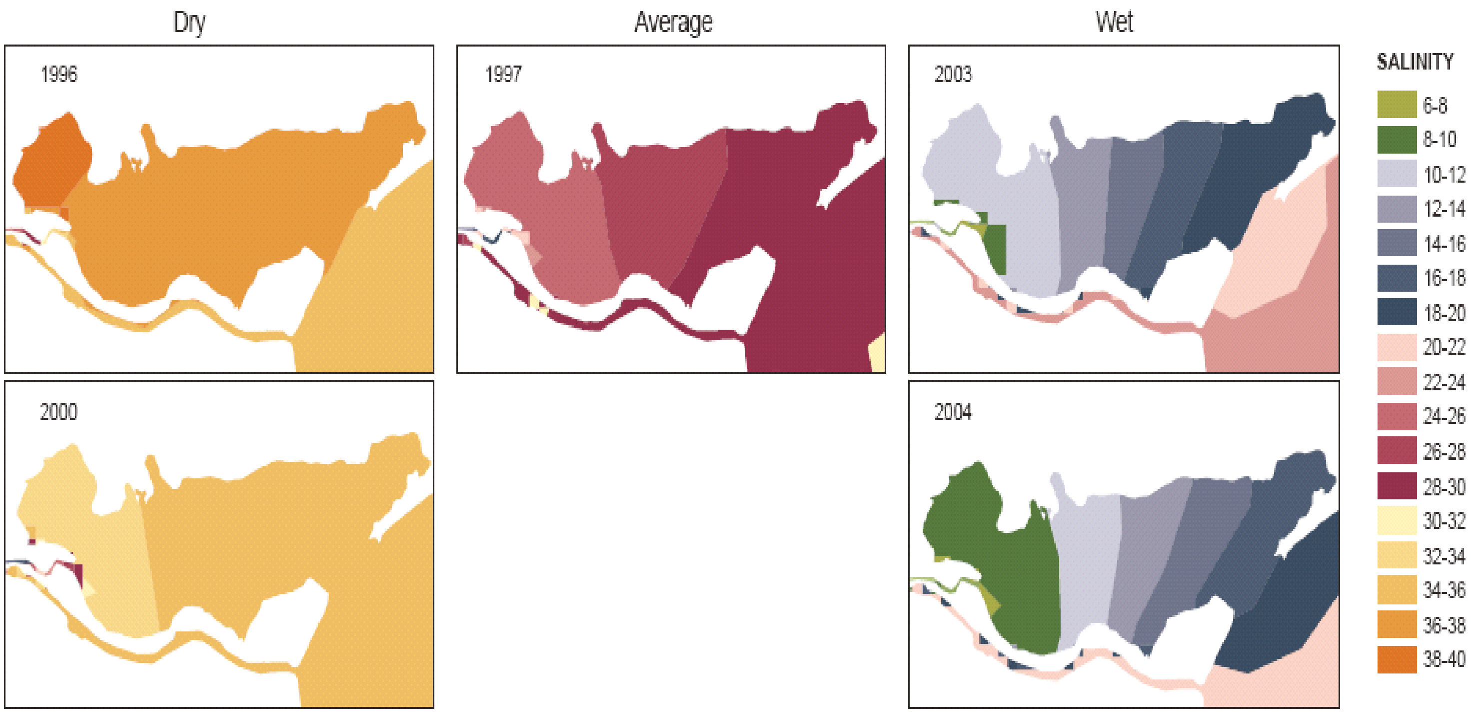
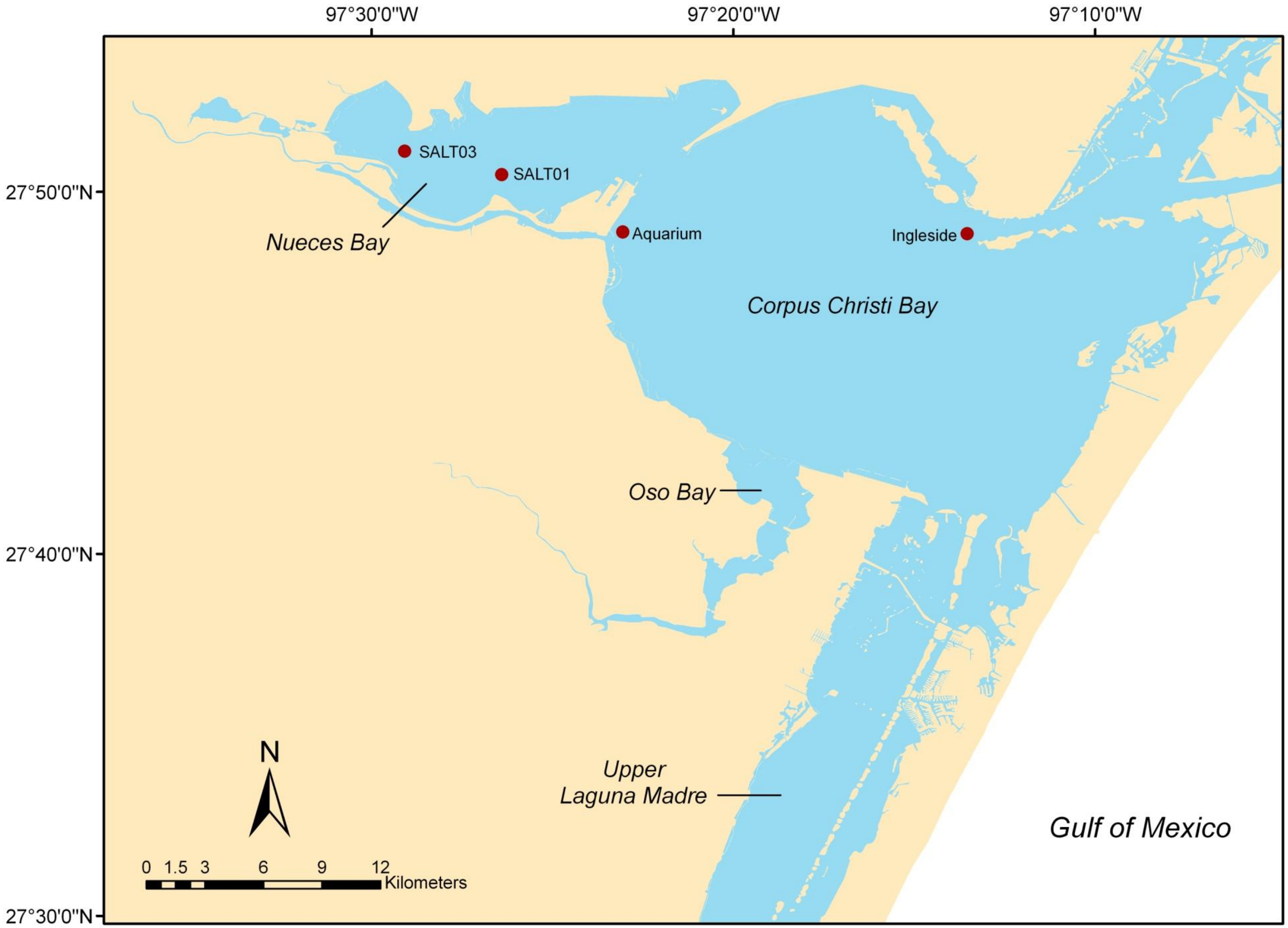


Figure X. Wet periods and two-year bins over the 14 year study period. From 1 January 1994 to 10 August 2000, wet periods were classified as daily flow rates exceeding 4.2 x 10^6 m^3 Nueces River flow. From 11 August 2000 to 29 February 2008 wet periods were classified as daily flow rates exceeding 2.6 x 10^6 m^3 Nueces River flow.

TxBLEND modeled salinity, August 2011 TWDB J. Matsumoto, GIS post processing TPWD L. Hamlin


Dry
Average
Wet
1996
1997
2003
2000
2004
SALINITY
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
30-32
32-34
34-36
36-38
38-40


97°30'0"W
97°20'0"W
97°10'0"W
27°50'0"N
27°40'0"N
27°30'0"N
SALT03
SALT01
Nueces Bay
Aquarium
Ingleside
Corpus Christi Bay
Oso Bay
Upper
Laguna Madre
Gulf of Mexico
N
0 1.5 3 6 9 12
Kilometers

Steps:

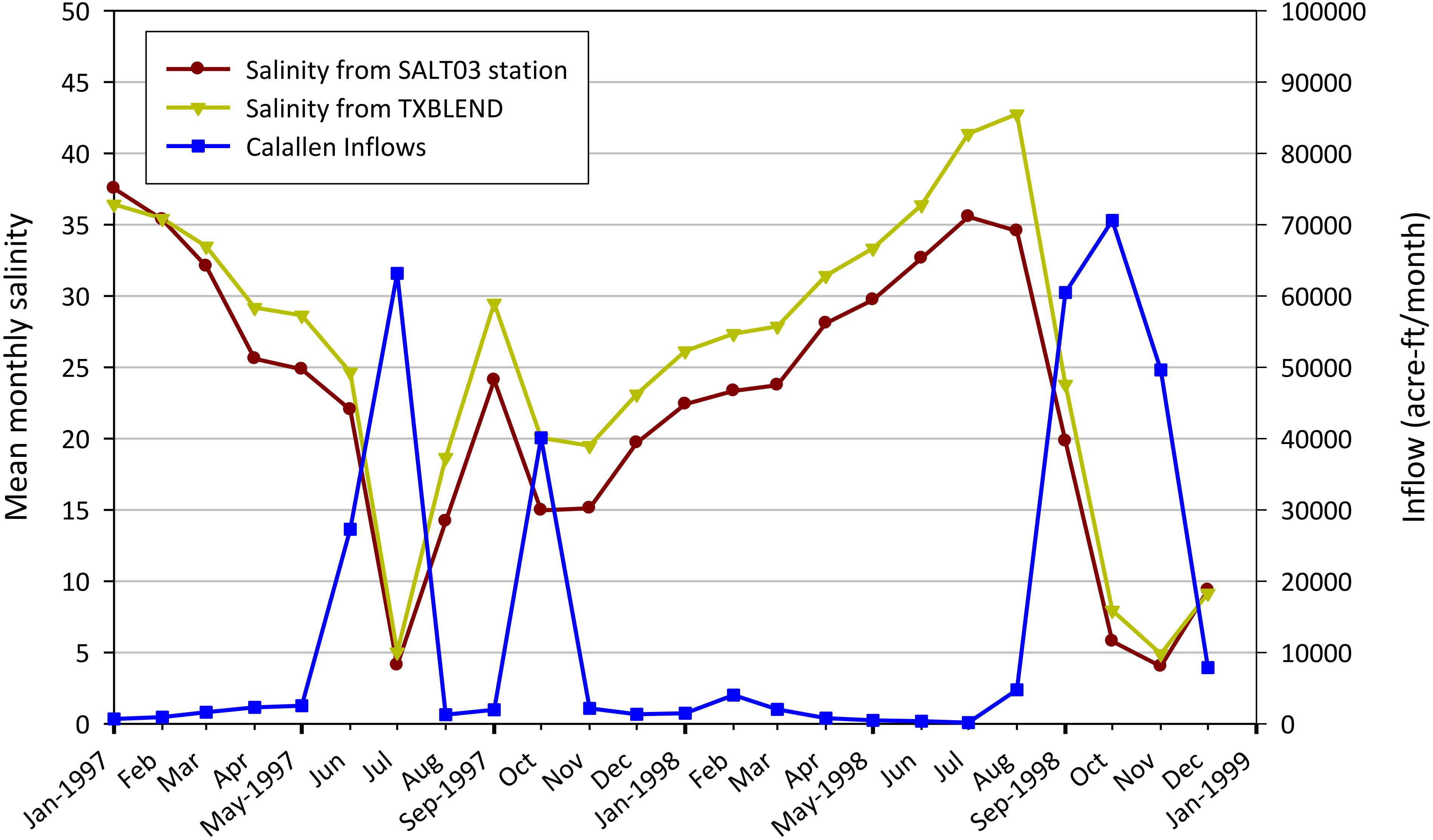
1. Characterize historical water availability patterns

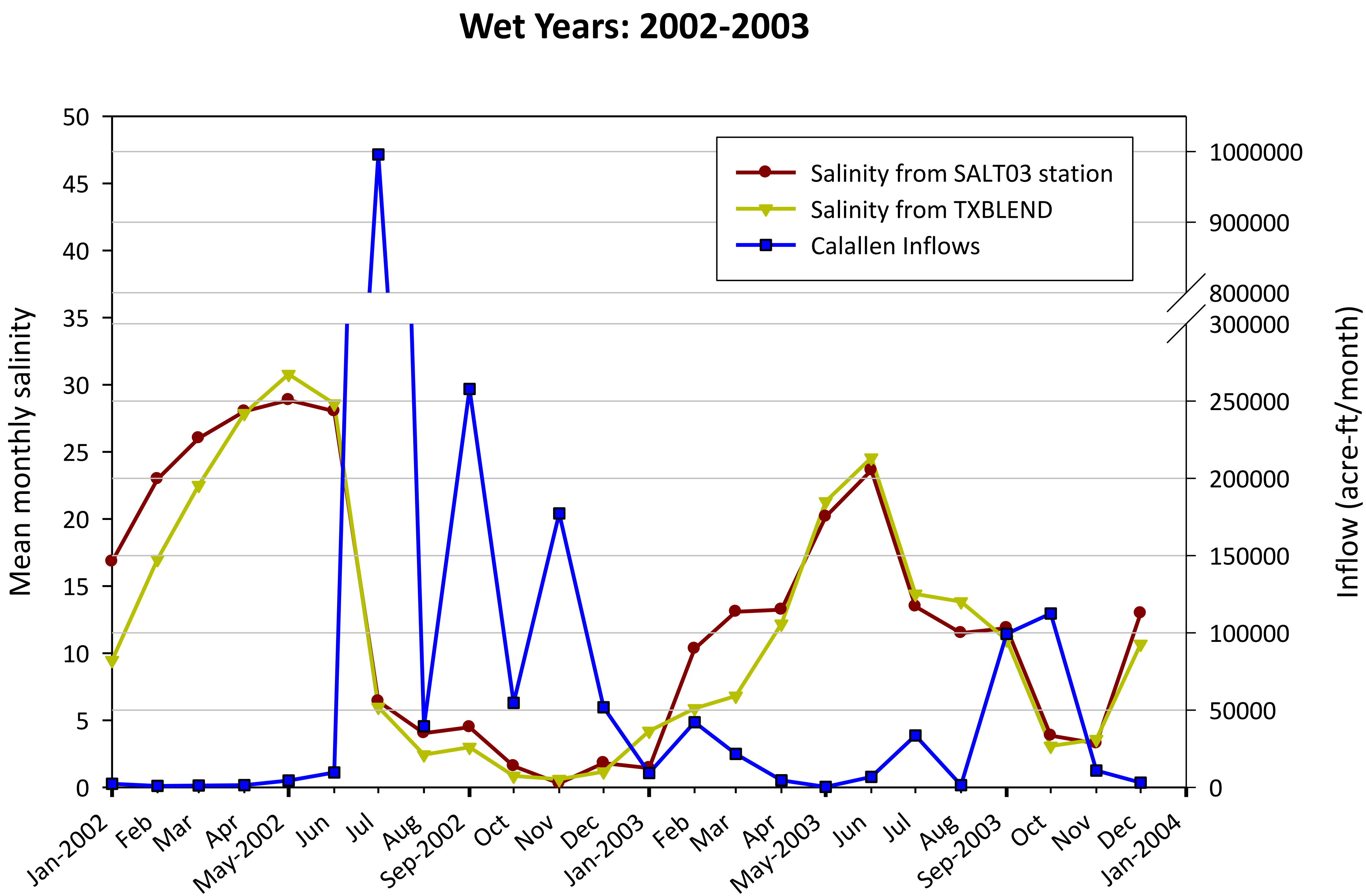
2. <u>Examine flow and salinity relationships</u>

3. Identify focal species (canaries)

4. Recommend flow that will create a sound environment

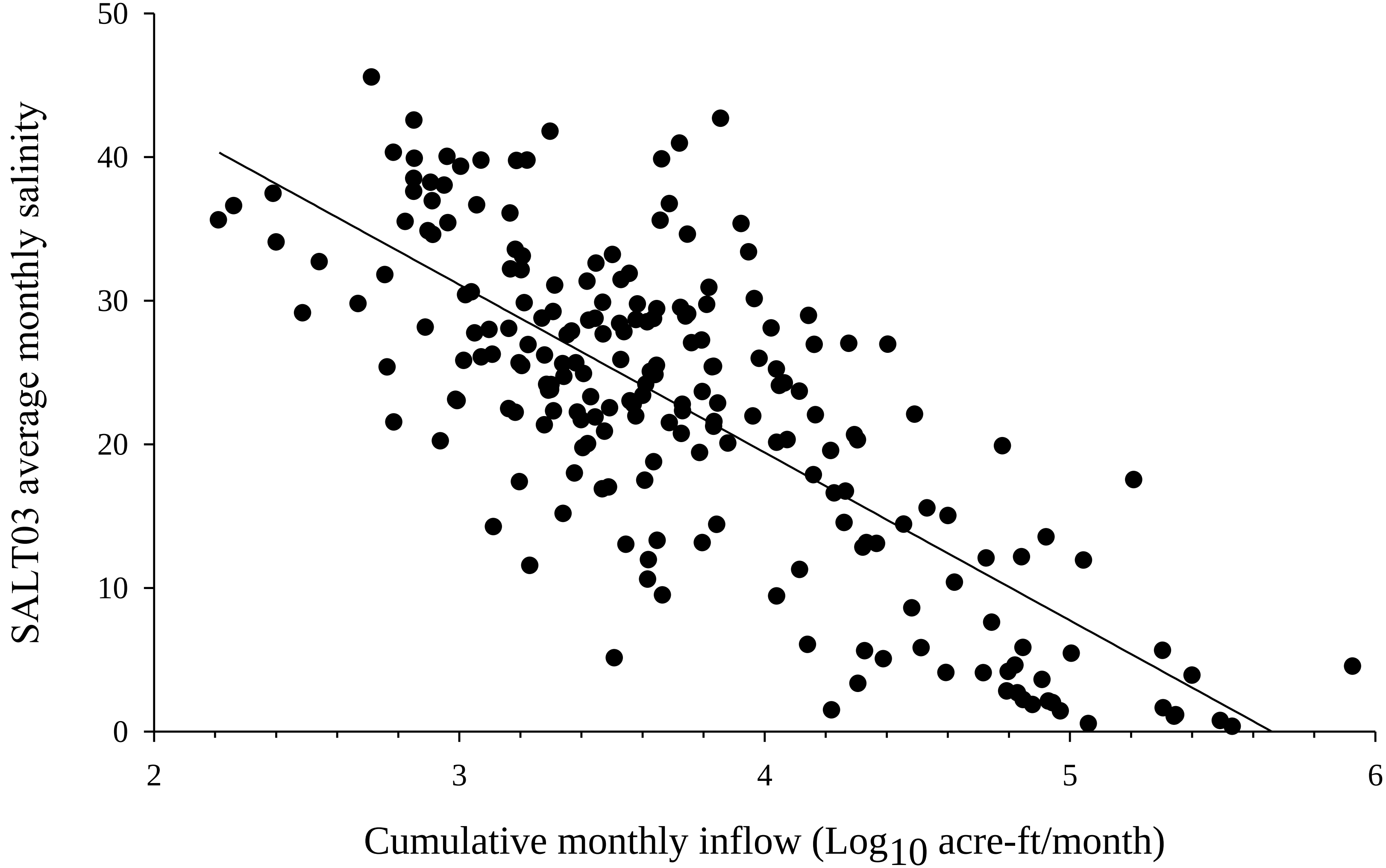
Average Years: 1997-1998



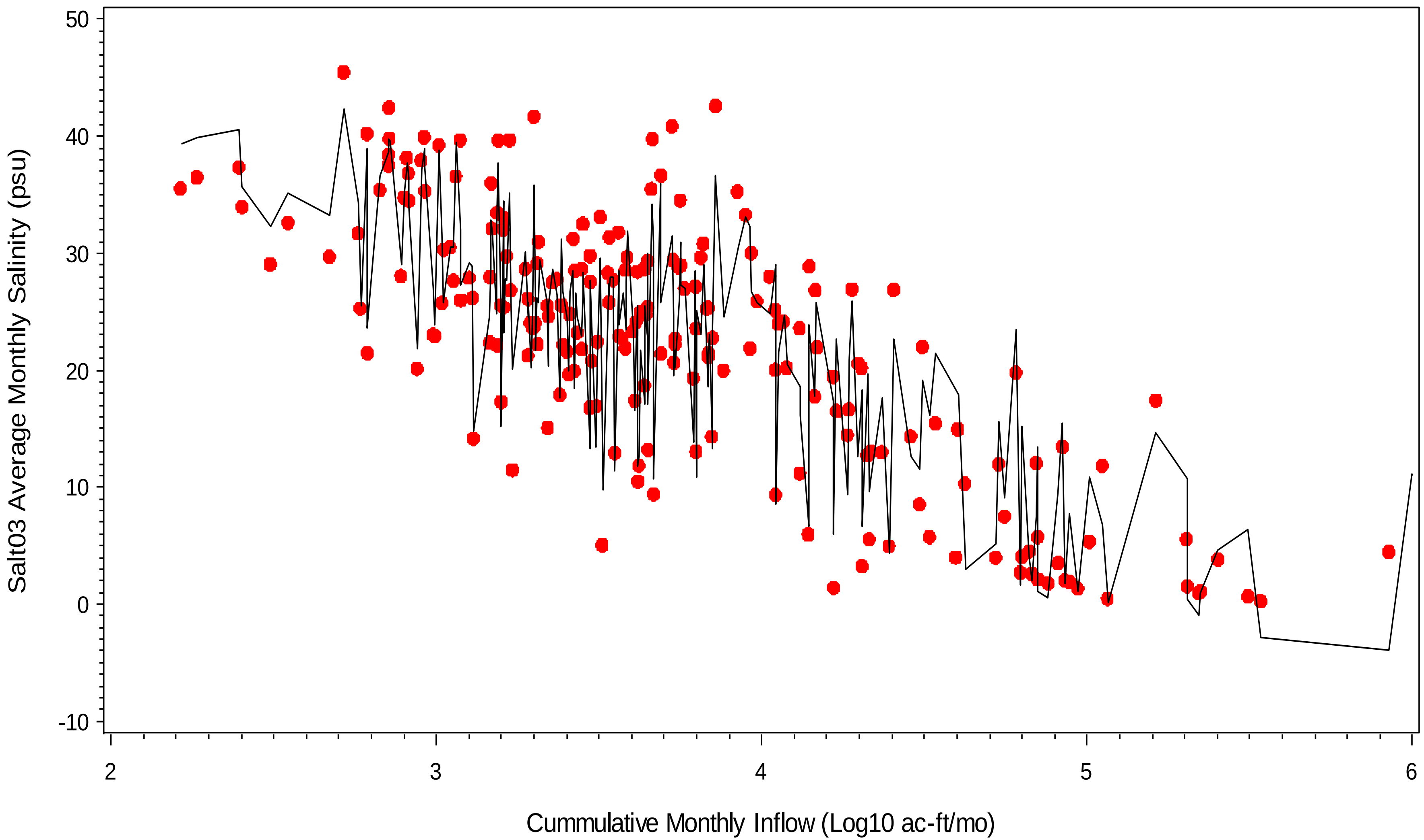


Wet Years: 2002-2003
Salinity from SALT03 station
Salinity from TXBLEND
Calallen Inflows
Mean monthly salinity
Inflow (acre-ft/month)
50
45
40
35
30
25
20
15
10
5
0
1000000
900000
800000
300000
250000
200000
150000
100000
50000
0
Jan-2002
Feb
Mar
Apr
May-2002
Jun
Jul
Aug
Sep-2002
Oct
Nov
Dec
Jan-2003
Feb
Mar
Apr
May-2003
Jun
Jul
Aug
Sep-2003
Oct
Nov
Dec
Jan-2004

A flow-salinity "key"…



Salinity = 66.183 – (11.690 x $\log_{10}$(inflow)); R^2 = 0.58.



Salinity = 32.85 - (6.648 * Log10(Inflow)) + 0.6480*PrevSal, R^2=0.90

Steps:

1. Characterize historical water availability patterns

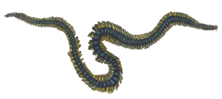
2. Examine flow and salinity relationships

3. <u>Identify focal species (canaries)</u>

4. Recommend flow that will create a sound environment

Species

Spartina alterniflora



Benthic Infauna

Crassostrea virginica

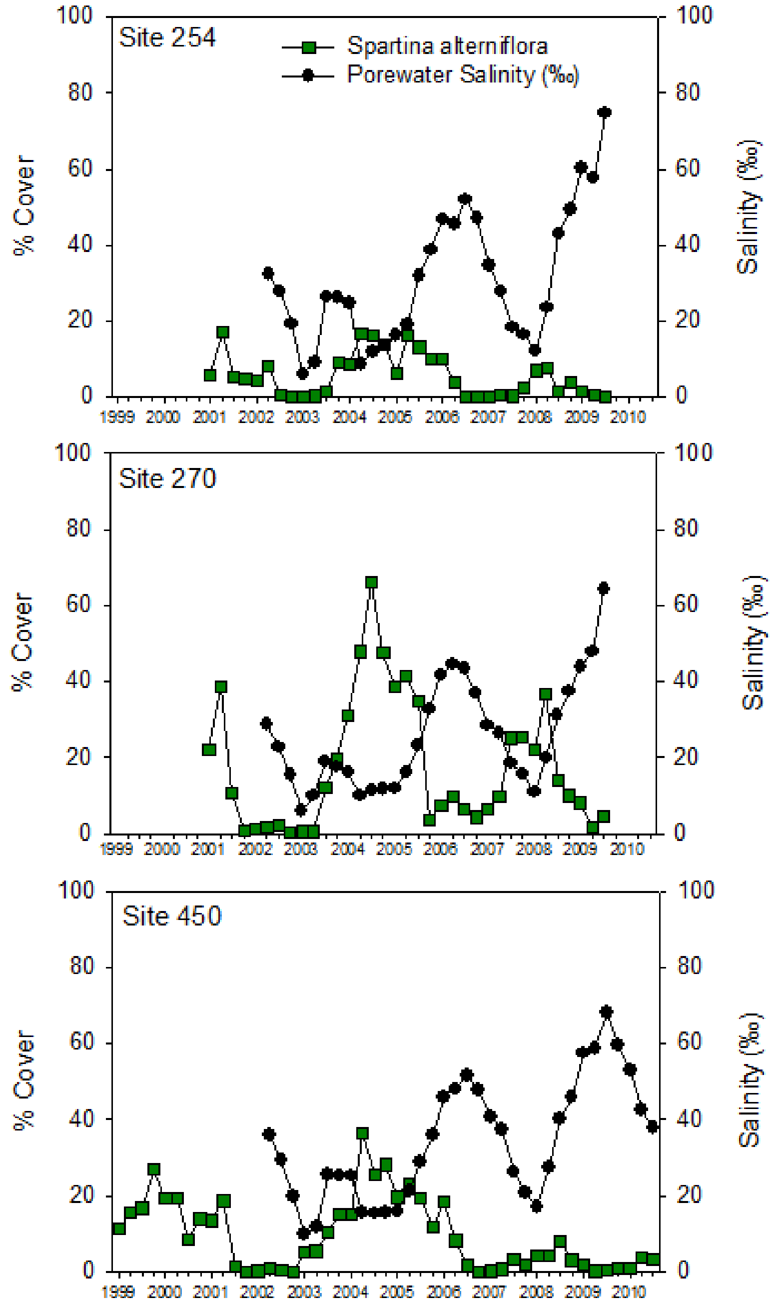
Callinectes sapidus

Micropogonias undulatus

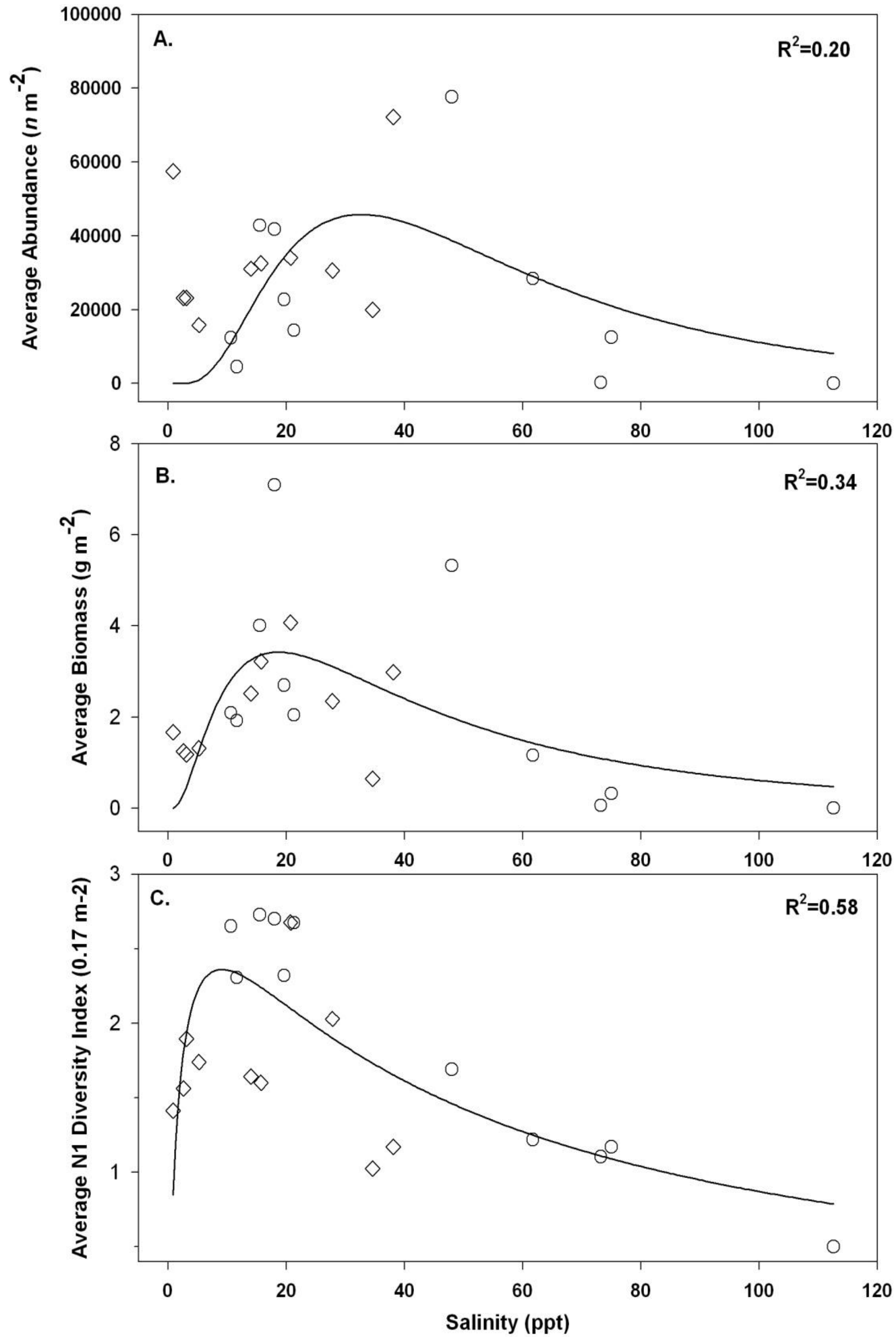
Key Indicator Species

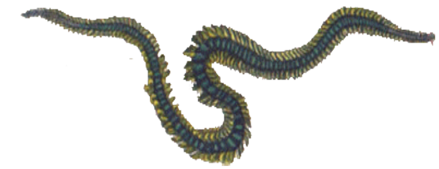
0 5 10 15 20 25 30 35 40

Salinity



Site 254
Spartina alterniflora
Porewater Salinity (‰)
% Cover
Salinity (‰)
Site 270
Site 450
0
20
40
60
80
100
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010


A.
R²=0.20
Average Abundance (n m⁻²)
100000
80000
60000
40000
20000
0
B.
R²=0.34
Average Biomass (g m⁻²)
8
6
4
2
0
C.
R²=0.58
Average N1 Diversity Index (0.17 m-2)
3
2
1
0
20
40
60
80
100
120
Salinity (ppt)



Predictive model: can we relate fish distribution patterns to environmental variables?

Abiotic

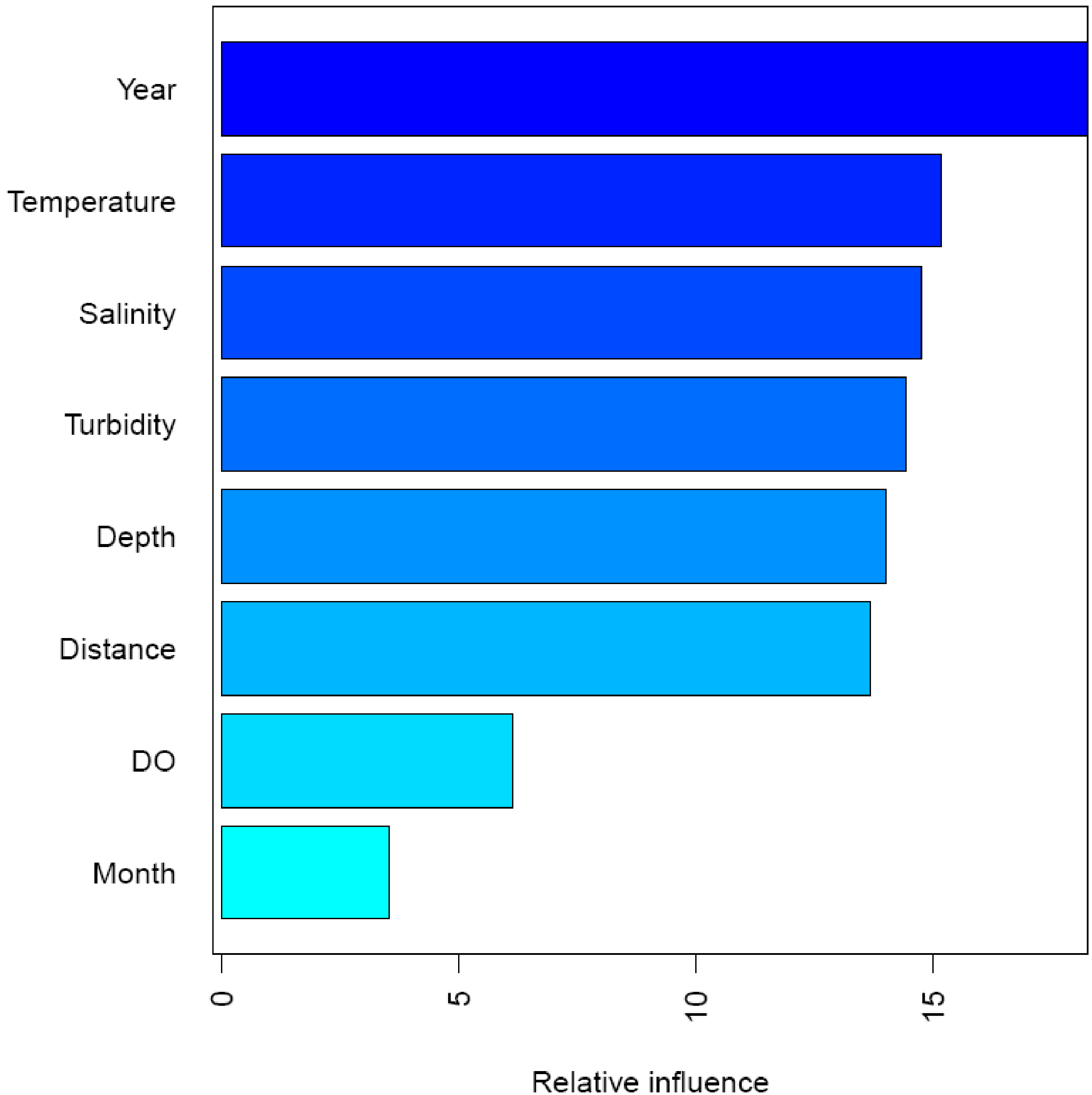
- Salinity
- Temperature
- Dissolved oxygen
- Depth
- Turbidity

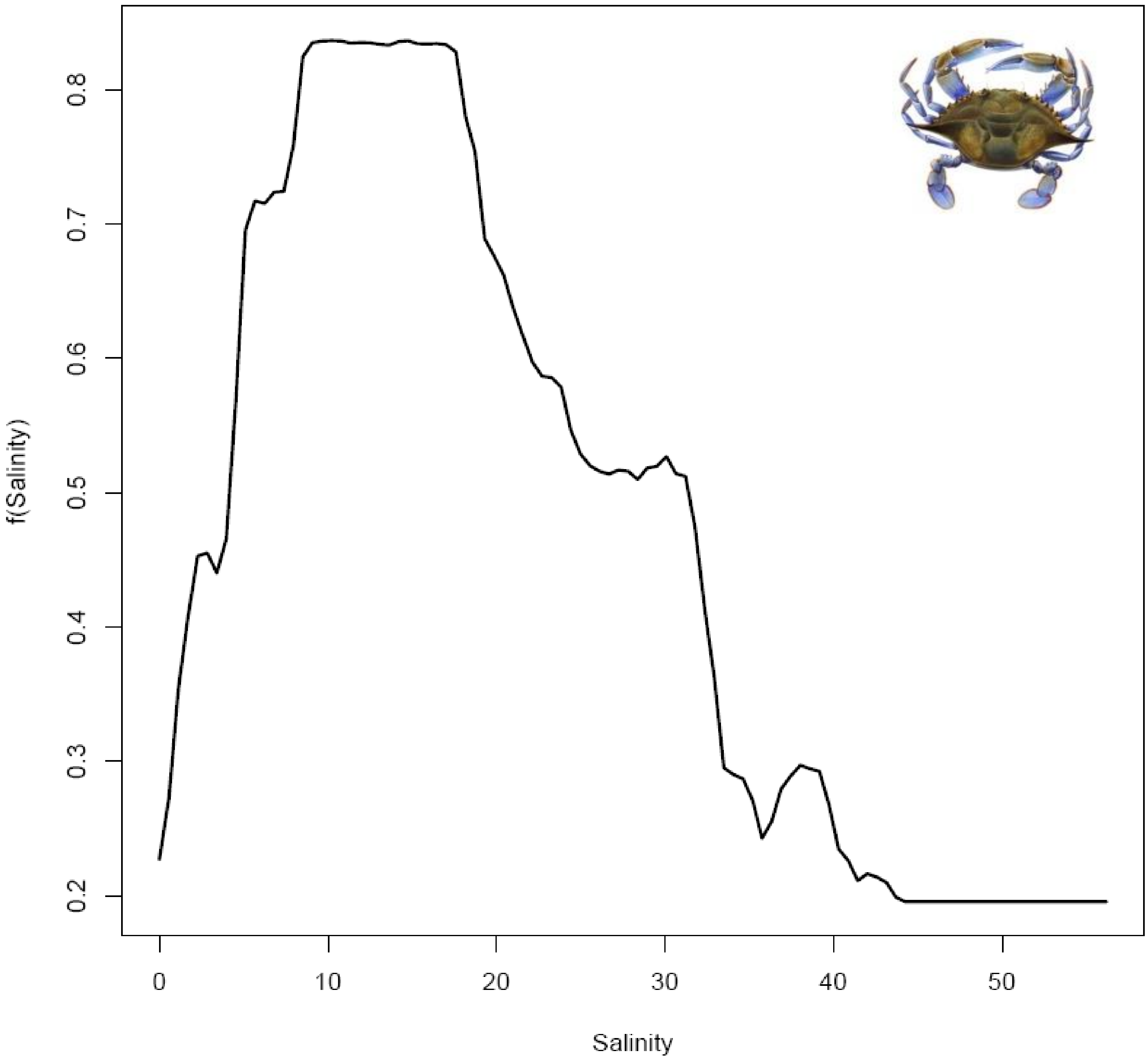
Spatial

- Distance to Inlet

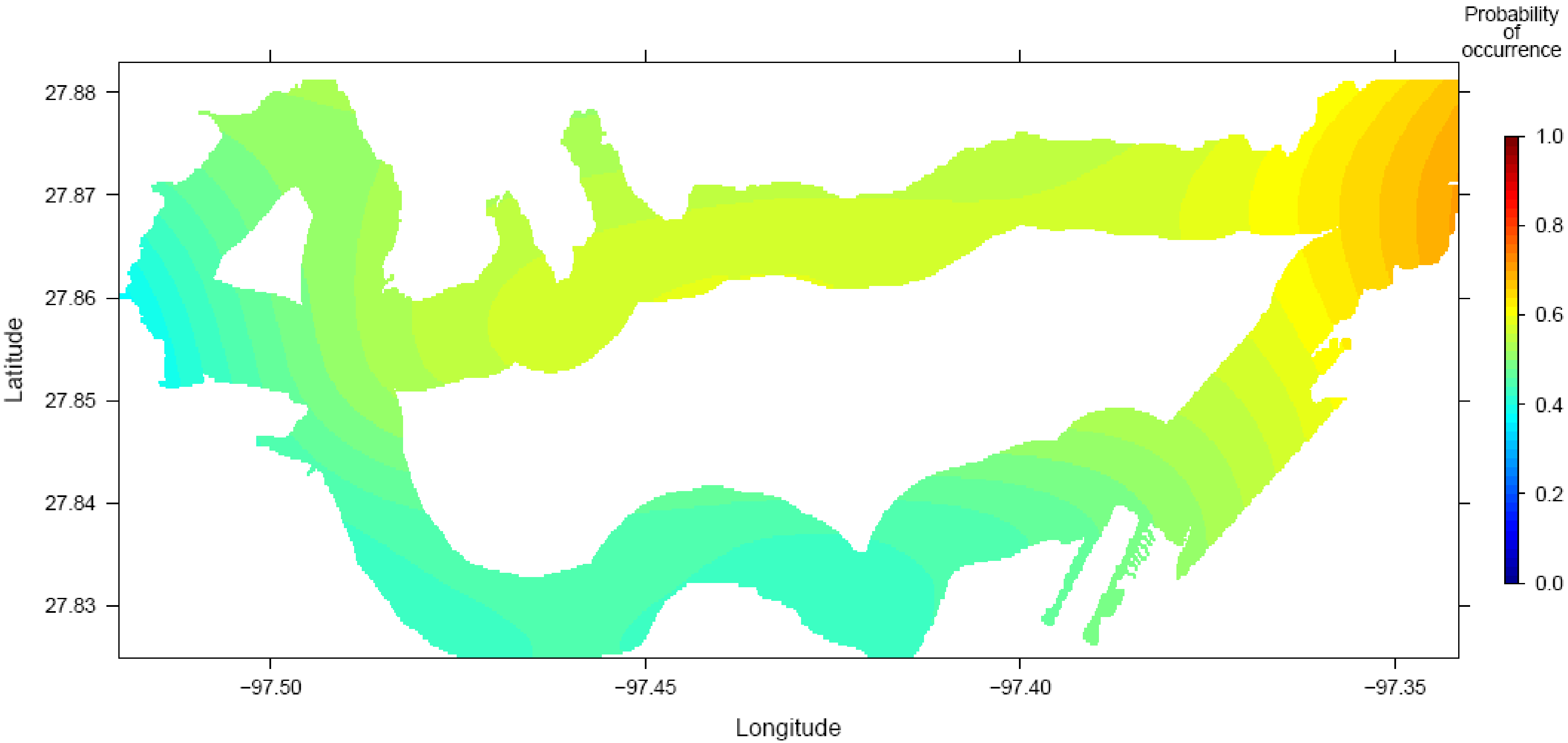
Temporal

- Month
- Year

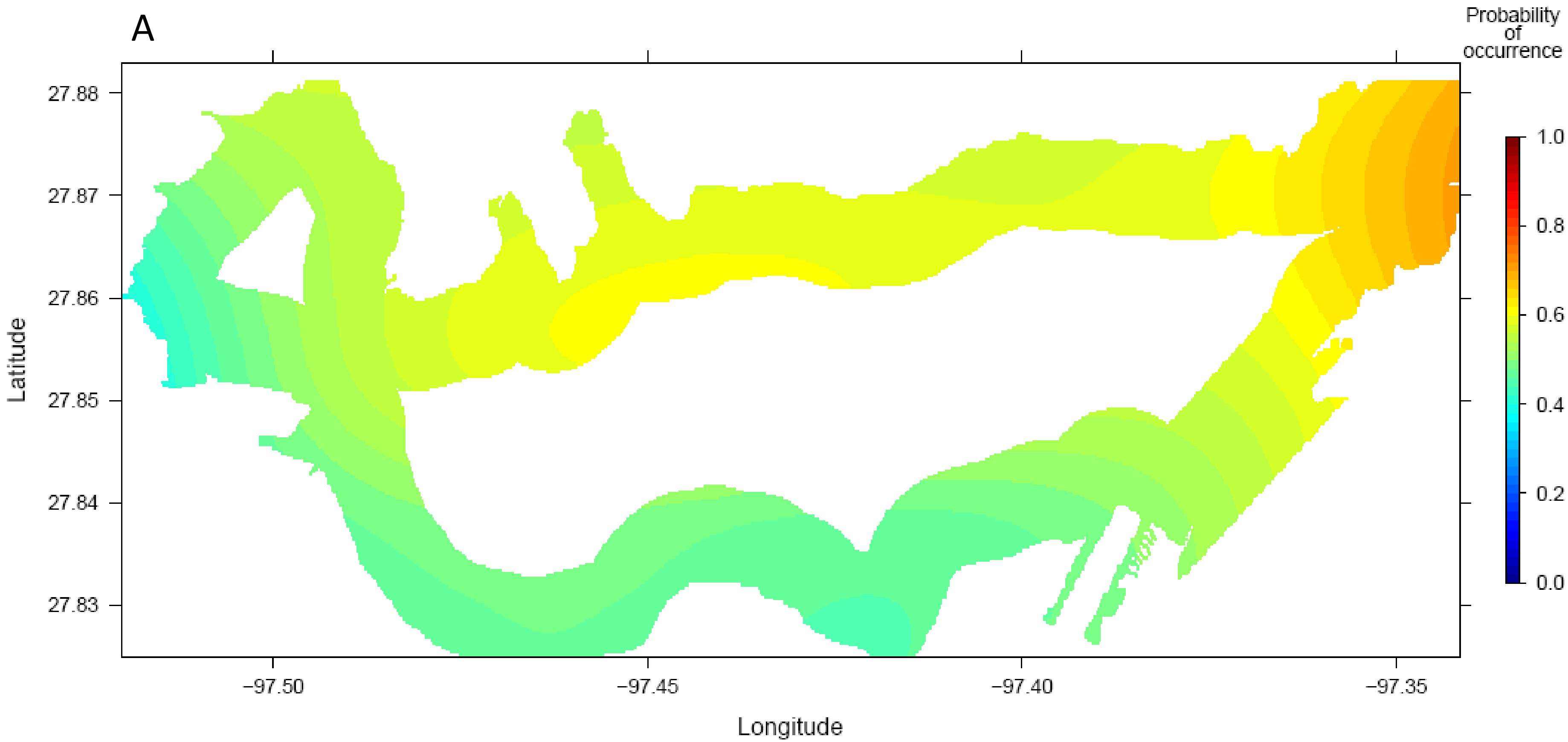

Year
Temperature
Salinity
Turbidity
Depth
Distance
DO
Month
0
5
10
15
Relative influence


f(Salinity)
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
10
20
30
40
50
Salinity

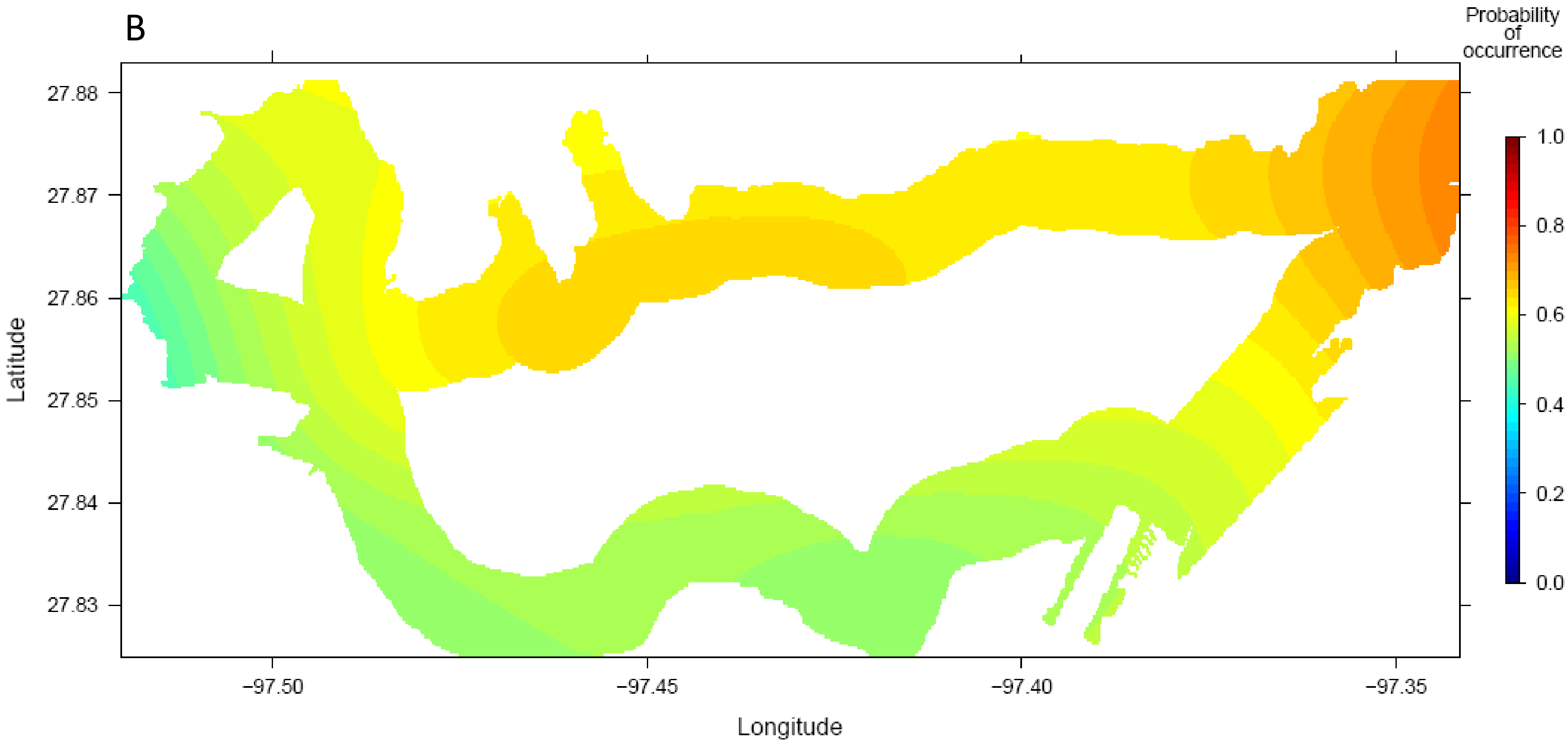
Blue crab mean frequency of occurrence



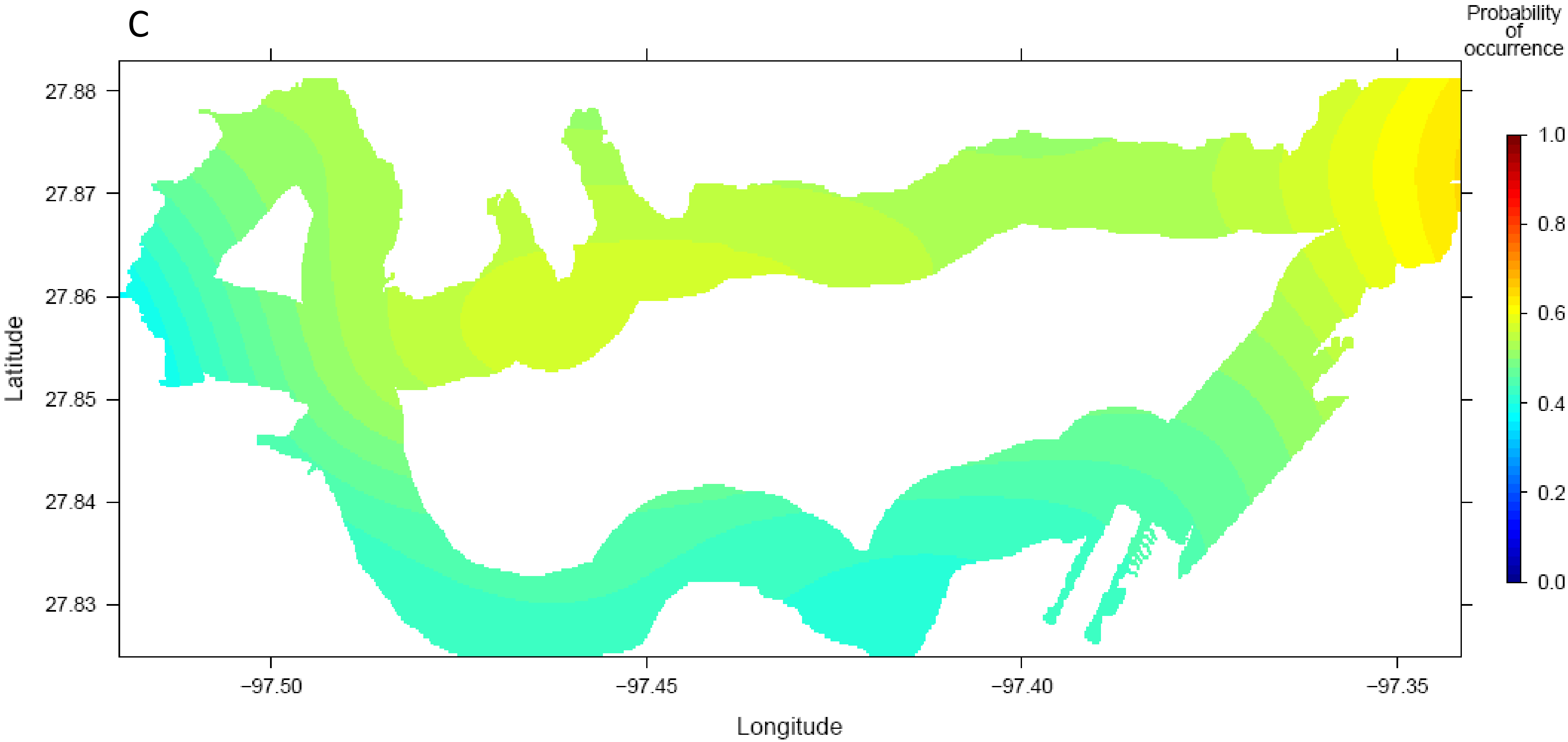
Blue crab frequency of occurrence (< 5)



Blue crab frequency of occurrence (< 10)



Blue crab frequency of occurrence (> 5)



Blue crab frequency of occurrence (> 10)

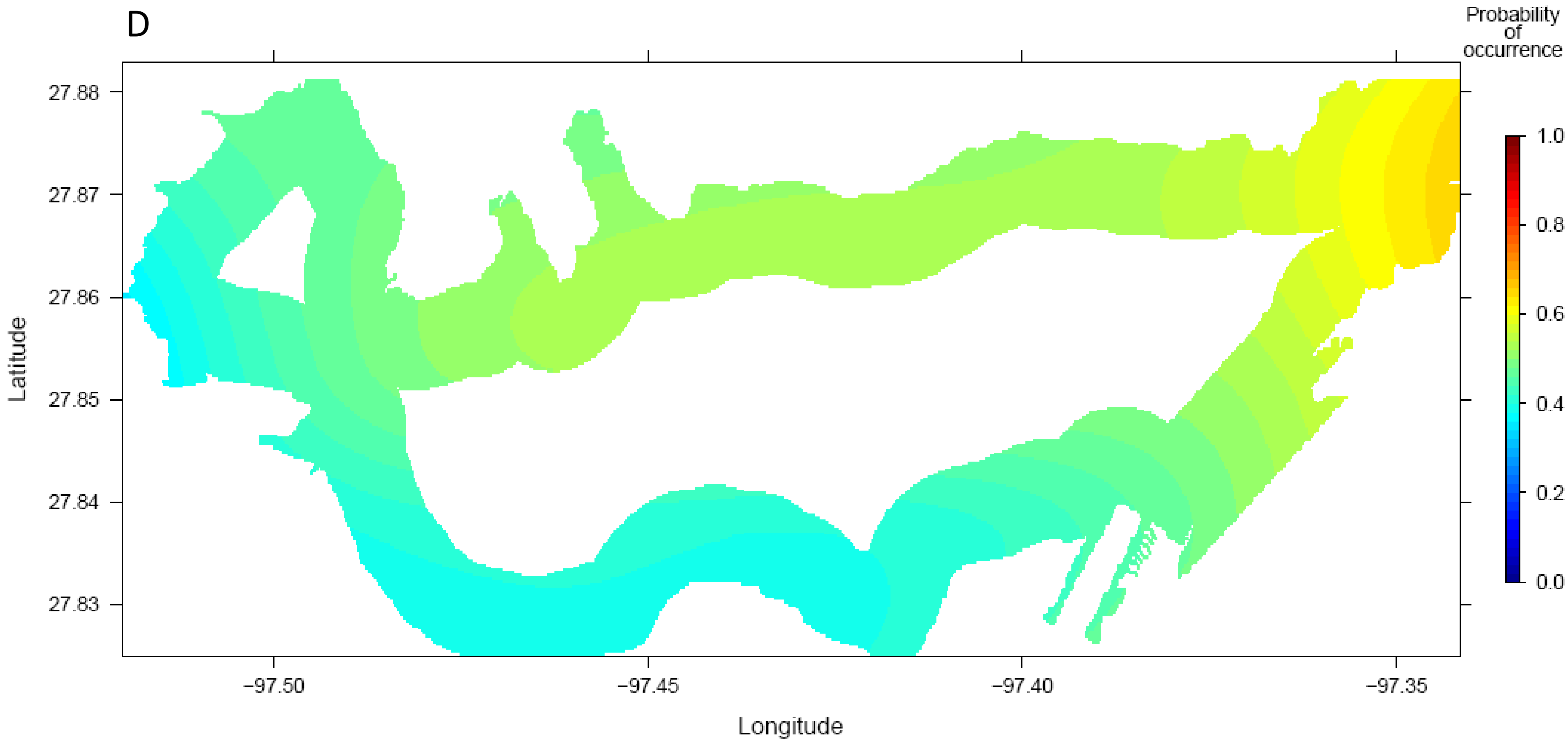
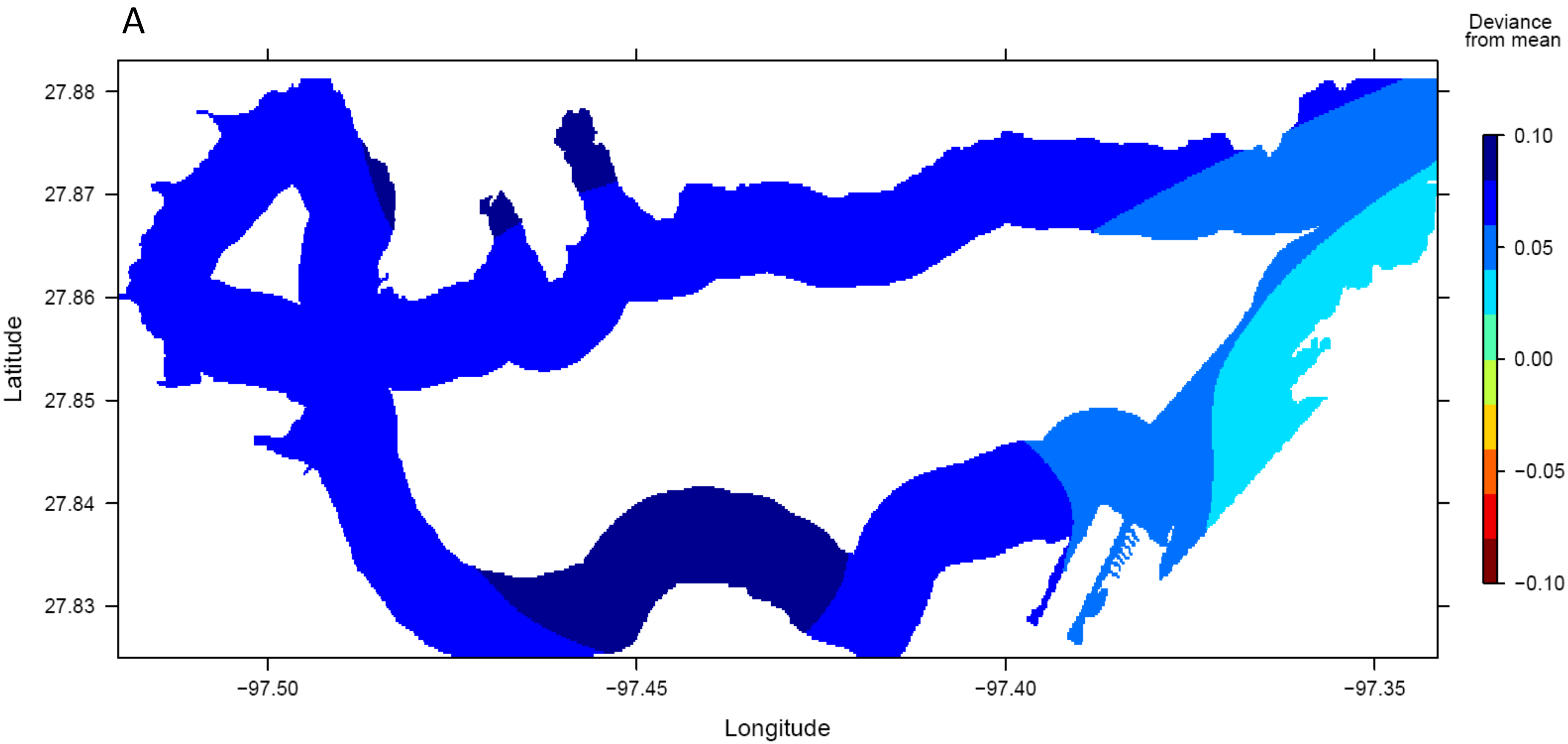
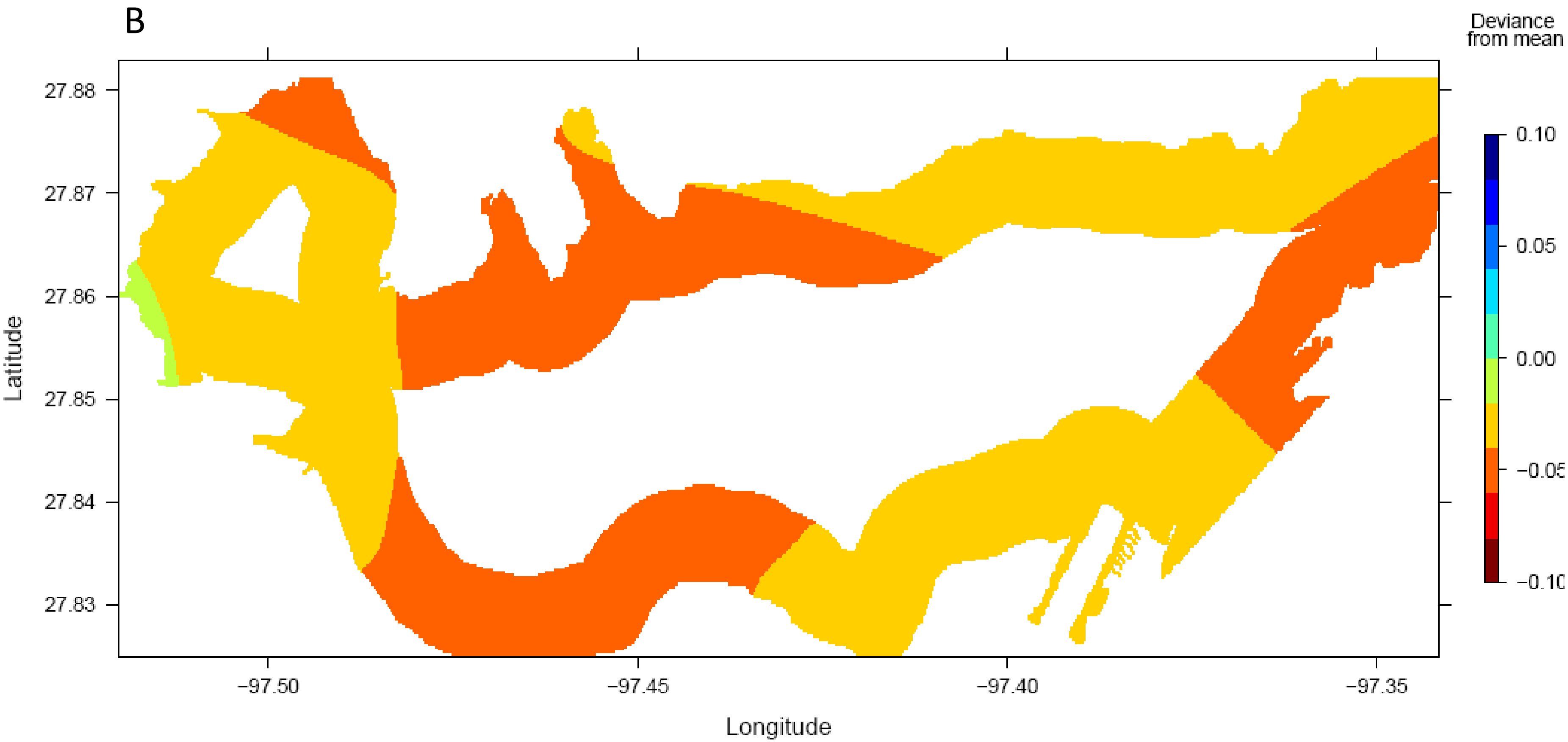


Figure X. Blue crab predicted frequency of occurrence salinity increased 10 from mean

Blue crab frequency of occurrence (< 10)

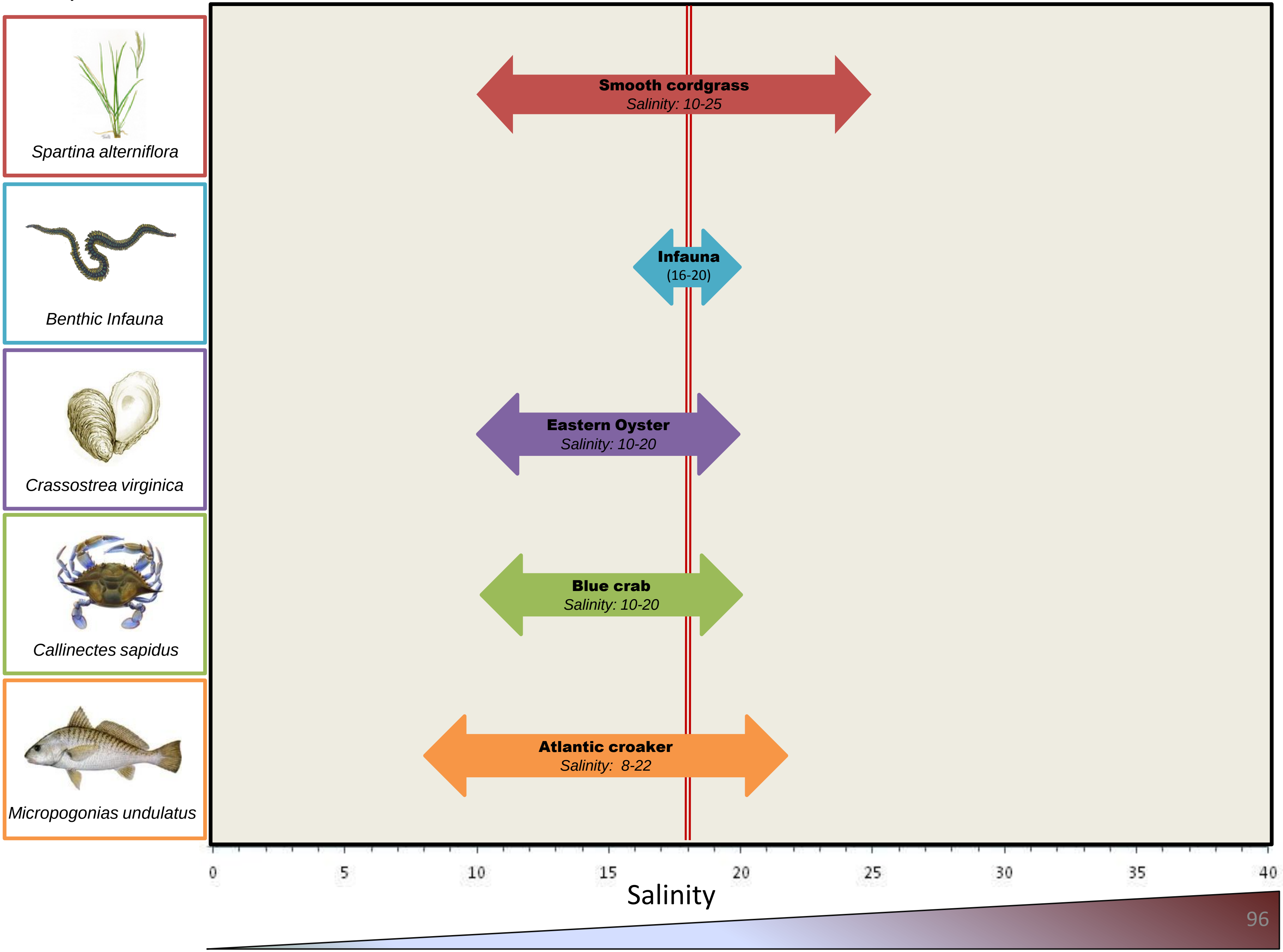


Blue crab frequency of occurrence (> 10)

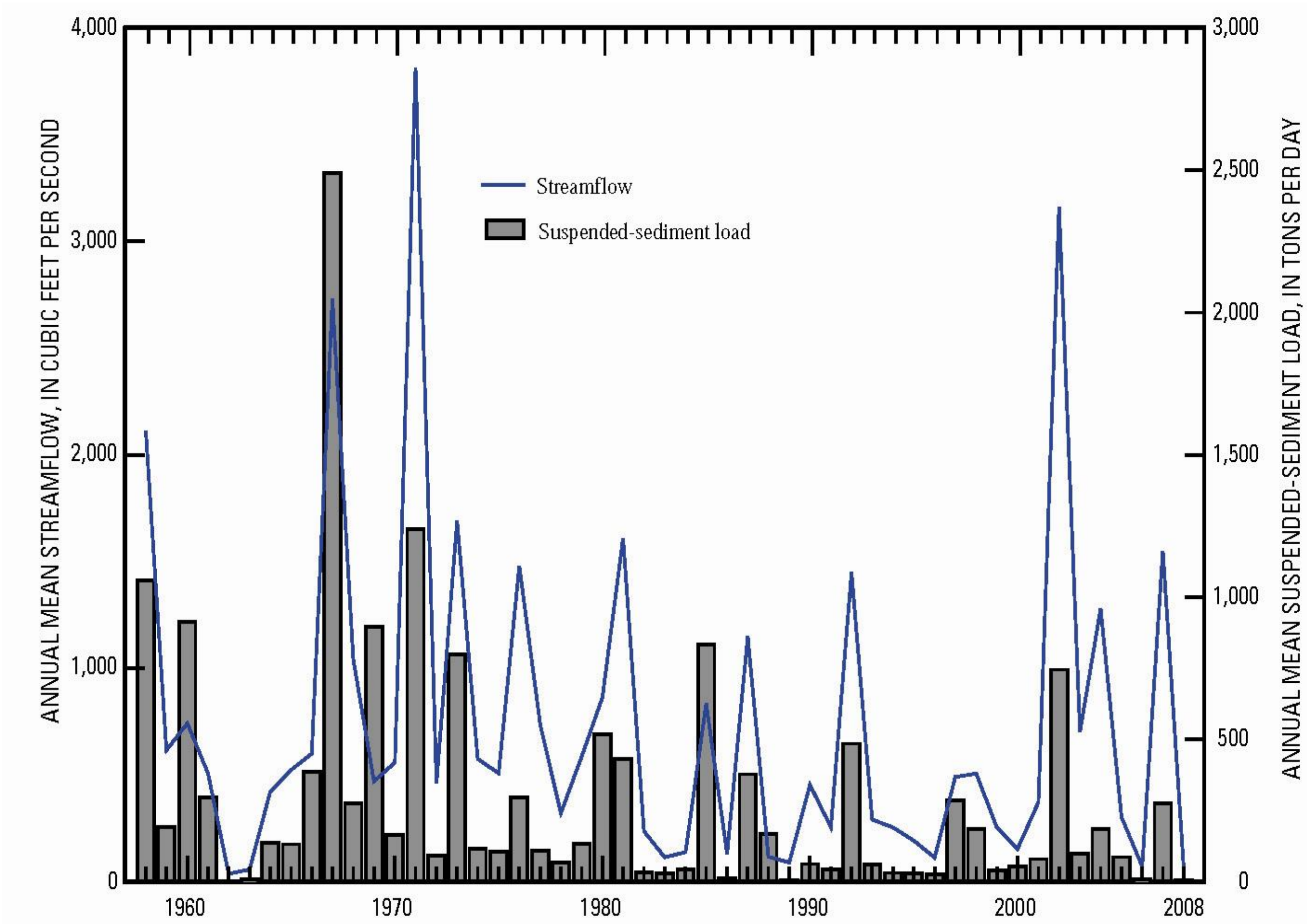


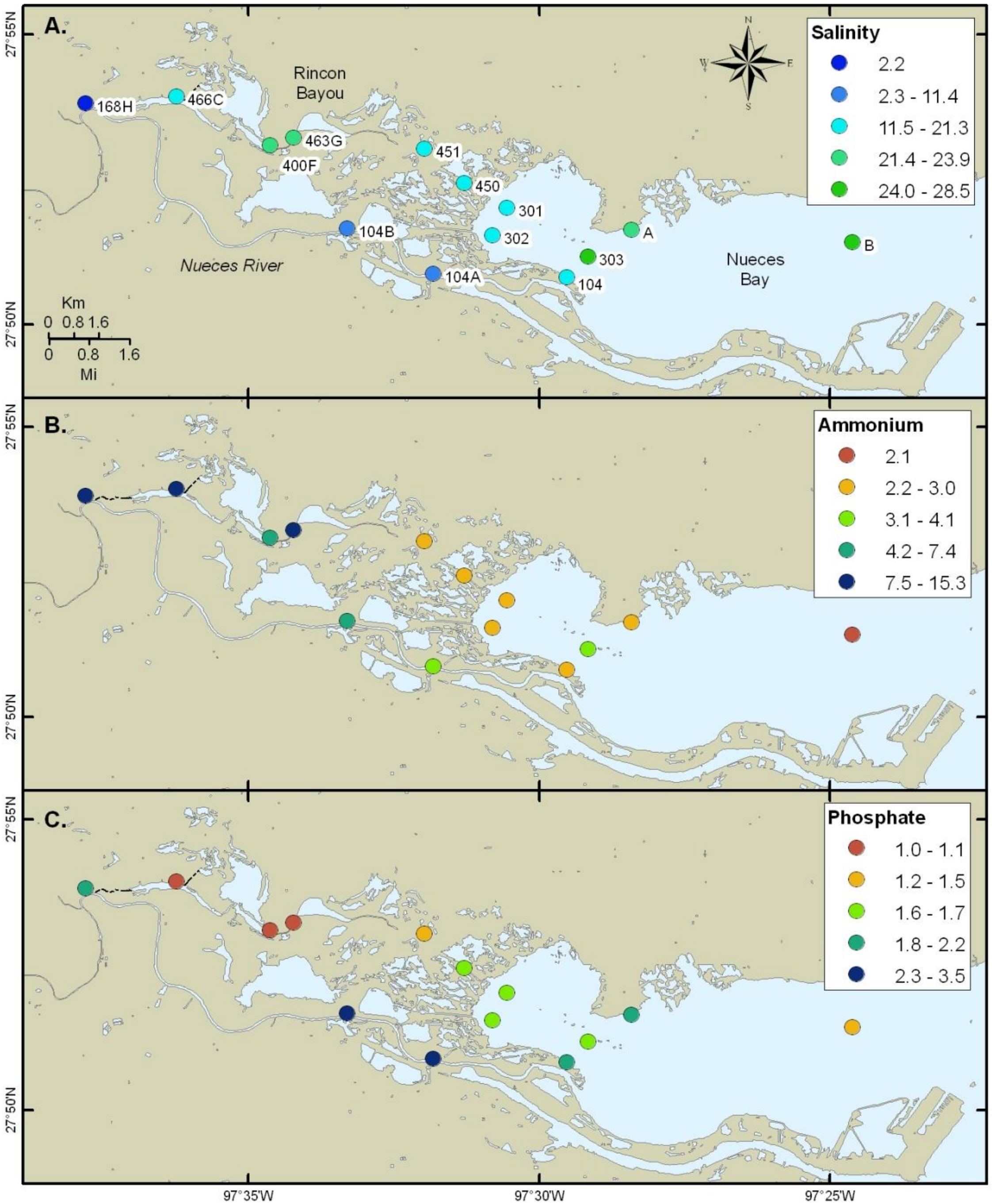
Indicator Species Profiles

Species



Sediment and Nutrient Considerations




A.
Salinity
2.2
2.3 - 11.4
11.5 - 21.3
21.4 - 23.9
24.0 - 28.5
Rincon Bayou
Nueces River
Nueces Bay
168H
466C
463G
400F
451
450
301
302
104B
104A
303
104
A
B
Km
0 0.8 1.6
0 0.8 1.6
Mi
B.
Ammonium
2.1
2.2 - 3.0
3.1 - 4.1
4.2 - 7.4
7.5 - 15.3
C.
Phosphate
1.0 - 1.1
1.2 - 1.5
1.6 - 1.7
1.8 - 2.2
2.3 - 3.5
27°55'N
27°50'N
97°35'W
97°30'W
97°25'W

Steps:

1. Characterize historical water availability patterns

2. Examine flow and salinity relationships

3. Identify focal species (canaries)

4. <u>Recommend flow that will create a sound environment</u>

Condition (Target Salinity)	Nueces Bay Freshwater Inflow Regime (Attainment)			Recommendations		Historical Attainment		
	1 overbanking event per year of 39,000 acre-ft; maximum discharge of 3600 cfs			Annual Total	Attainment	1941-2009	1941-1982	1983-2009
High (10)	125,000 Acre-ft (20%)	250,000 Acre-ft (25%)	375,000 Acre-ft (20%)	750,000	25%	22%	26%	15%
Base (18)	22,000 Acre-ft (60%)	88,000 Acre-ft (60%)	56,000 Acre-ft (75%)	166,000	80%	67%	81%	44%
Subsistence (34)	5,000 Acre-ft (95%)	10,000 Acre-ft (95%)	15,000 Acre-ft (95%)	30,000	95%	94%	100%	85%
	Nov Dec Jan Feb	Mar Apr May Jun	Jul Aug Sep Oct					
	Winter	Spring	Summer Fall					

	Nueces River Flow (Acre-ft)			
Nueces Delta Porewater Target Salinity	22,000 (244/day)	88,000 (978/day)	38,000 (422/day)	18,000 (200/day)
25	**Winter**	**Spring**	**Summer**	**Fall**

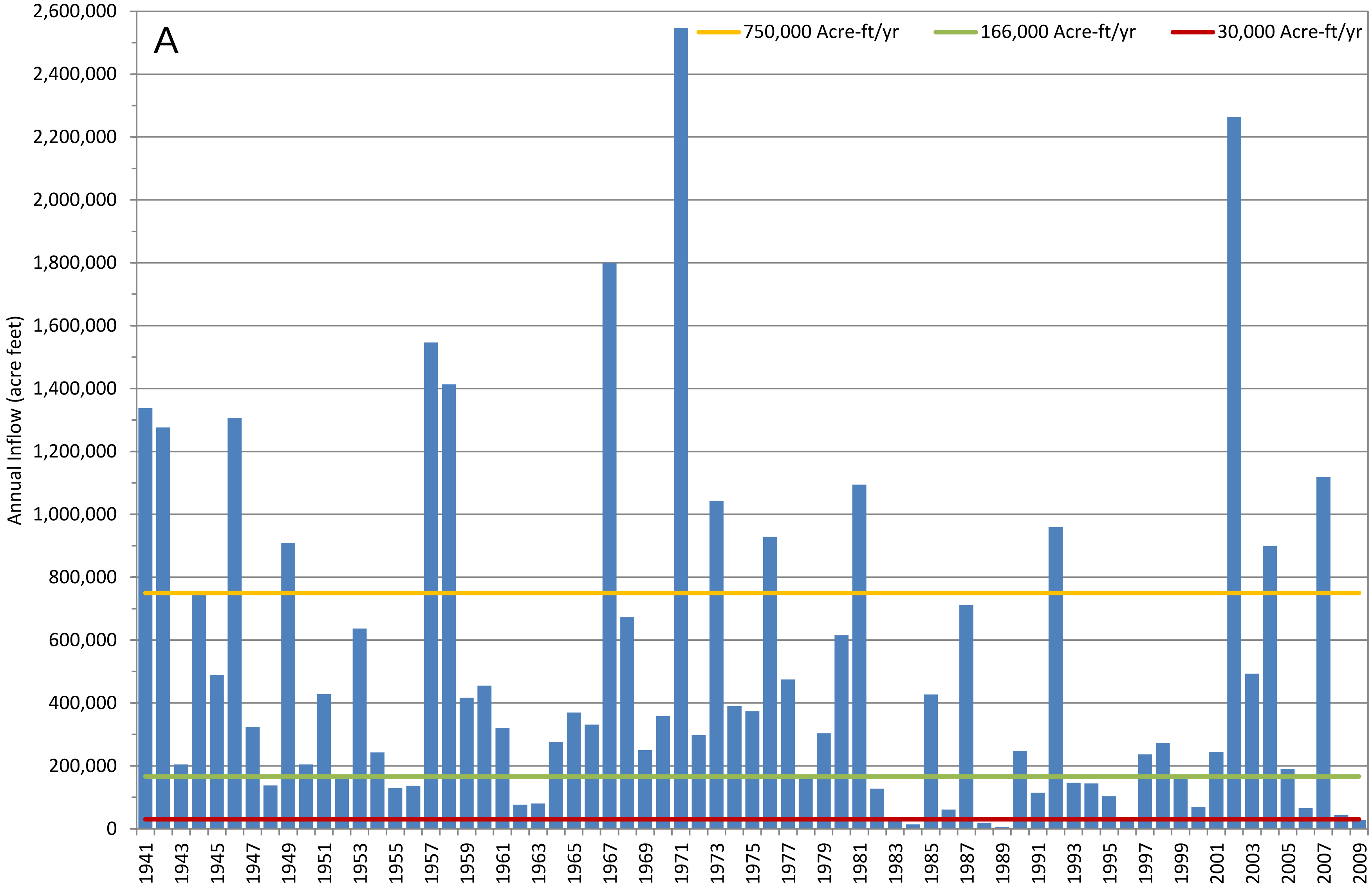
- We set target salinities based on indicator species' salinity requirements for base condition. We then used TxBLEND model outputs to generate target salinities that correspond with high and subsistence conditions.

- We used the below regression from Nueces Bay inflow and SALT03 station to calculate freshwater inflow that would generate target salinities. However, based on marsh plant salinity requirements in the delta there needs to be an annual inflow of 166,000 acre-ft. Therefore, the bay-calculated inflow of 160,000 acre-ft was increased by an additional 6,000 acre-ft to meet base conditions for marsh plants. We also examined historical inflow regimes and determined what the inflow was 95% of the time during the full period of record (1941-2009). We used that inflow as the basis for the annual recommendation for subsistence conditions.

$$\text{Salinity} = 66.183 - (11.690 \times \text{Log}_{10}(\text{Inflow}))$$

- The allocation for seasonal inflow requirements were based on meeting the biological needs of all indicator species, while accounting for historical patterns of water availability.

- Attainment recommendations were based on historical inflow patterns and how often these conditions were met taking into consideration flow regime changes pre- and post-dam flows.



A
750,000 Acre-ft/yr
166,000 Acre-ft/yr
30,000 Acre-ft/yr
Annual Inflow (acre feet)
2,600,000
2,400,000
2,200,000
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1941
1943
1945
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
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2009